Installation of Diverse Sand/ZVI Mixtures in the Construction of Permeable Reactive Barriers (PRBs)

Kelly Redevelopment and Goose Creek

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Former Kelly AFB PRB

Zone 5, Building P1533 PRB

Former Kelly Air Force Base

San Antonio, Texas

Scope of Work

- **Construction of 24-Inch wide, 650-Foot Long Sand-Iron Filings PRB**
- **PRB Depth Ranged from 34.5 to 43.5 Feet with Total Facial Area of Approximately 26,700 Square Feet**
- **PRB Excavated Using Biopolymer Slurry through Consolidated Seams of Gravel, Sandstone and Claystone**
- **Trench Keyed 1-foot into Underlying Navarro Clay Layer**

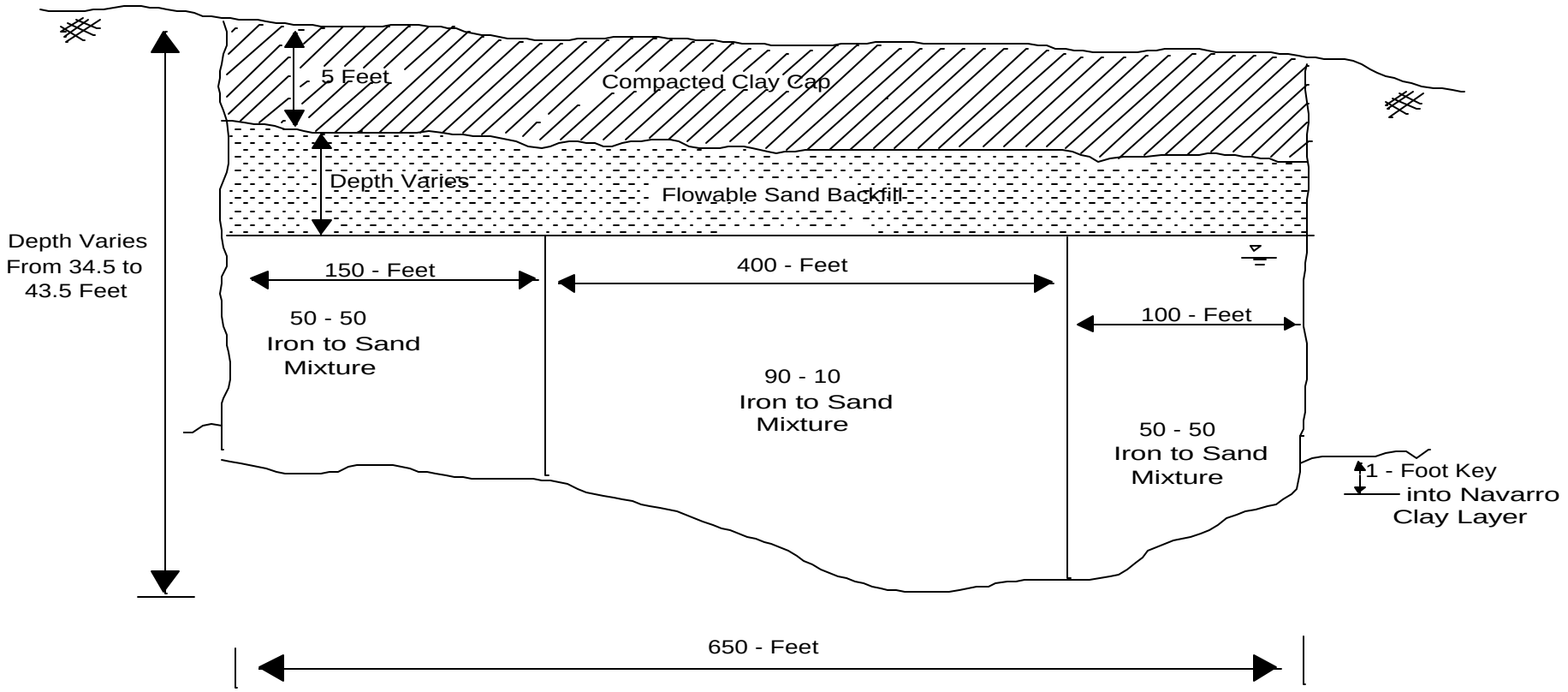
Scope of Work (Continued)

- Trench Backfilled with Sand-Iron Treatment Media Using Tremie Method
- Two Treatment Media Blends Used (50%:50% & 90%:10% Sand to Iron By Volume)
- Treatment Media Placed up to 1-Foot Above Groundwater Table
- Remaining Upper Portion Backfilled with “Sand Flowable Fill” and Capped With 5-Foot of Clay
- (4) In-Trench PVC Wells Installed to Develop Trench and Monitor Groundwater

Contaminants of Concern

- Acetone
- Chlorobenzene
- Chloroform
- 1,1-Dichloroethylene
- Tetrachloroethylene
- Trichloroethylene
- COC Concentrations Ranged from 1 to 23 ug/l

Constructed PRB Schematic



Zone 5, Building P1533 PRB Schematic

(NTS)

PRB Excavation under Slurry

Tremie Pipe Placement

Sand-Iron Mixing Process

Sand-Iron Mixing Process

Sand-Iron Tremie Process

Sand-Iron Tremie Process

Goose Creek PRB

Solid Waste Management Unit 12 Permeable Reactive Barrier (PRB)
Naval Weapons Station
Charleston, South Carolina

Scope of Work

- Construction of 36-Inch wide, 130-Foot Long Iron & Sand-Iron PRB
- PRB Depth Ranged from 37.0 to 40.0 Feet
- PRB Excavated Using Biopolymer Slurry through Interbeded Layers of Clay & Sandy Clay
- Trench Keyed 2-feet into a Confining Clay Unit
- Trench Backfilled with Pure Iron and Various Ratios of Sand-Iron Treatment Media

Scope of Work (Continued)

- Treatment Media Place Using Tremie Method
- Elevated Work Platform was Constructed 5-Foot Above Natural Surface Due to High Groundwater Conditions
- Three Treatment Media Blends (By Weight) Used as Follows;
  - 20 % : 80 % Iron Filings to Sand
  - 50 % : 50 % Iron Filings to Sand
  - 100 % Zero-Valent Iron

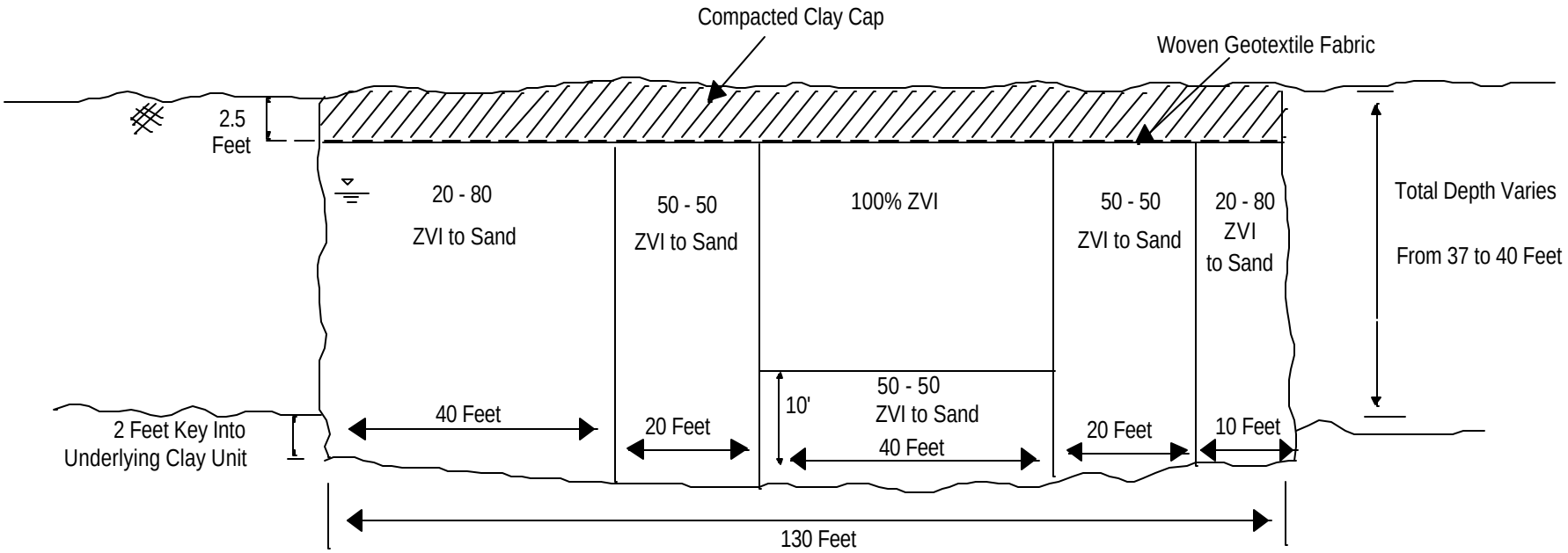
Scope of Work (Continued)

- **Media Placed up to 2.5-Feet Below Original Ground Surface**
- **PRB Capped with Woven Geotextile Fabric and 2.5-Feet of Clay**
- **PVC In-Trench Wells Installed to Develop Trench & Monitor Groundwater**

Contaminants of Concern

- Vinyl Chloride
- 1,1 Dichloroethene
- 1,1 Dichloroethane
- CIS 1,2 Dichloroethene
- 1,2 Dichloroethene
- 1,1,1-Trichloroethane
- Trichloroethene
- Tetrachloroethene
- COC Concentrations Ranged from 2,200 to 400,000 ppb

Constructed PRB Schematic



Schematic of Goose Creek PRB (NTS)

Work Platform Construction

Tremie Pipe Placement

Sand-Iron Mixing Process

Sand-Iron Conveyance to Trench

Typical Slurry Batch Plant

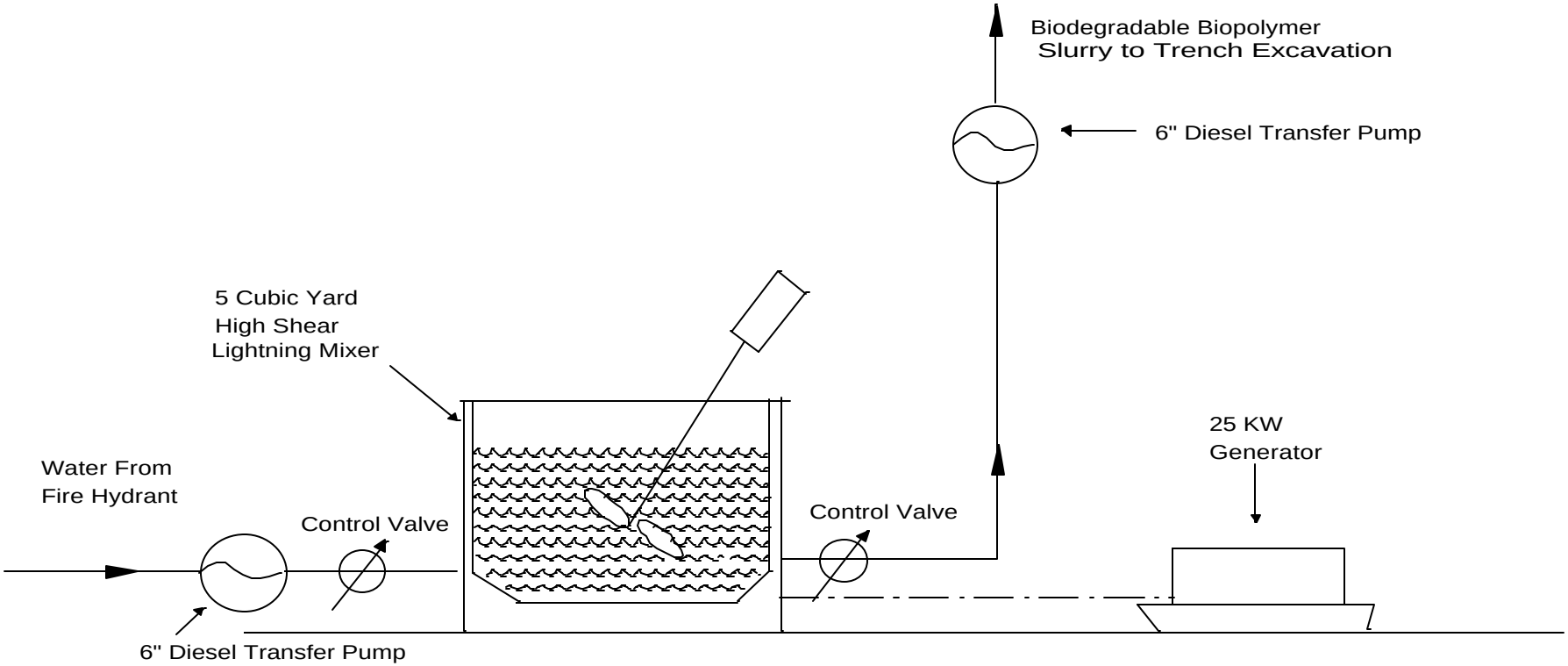
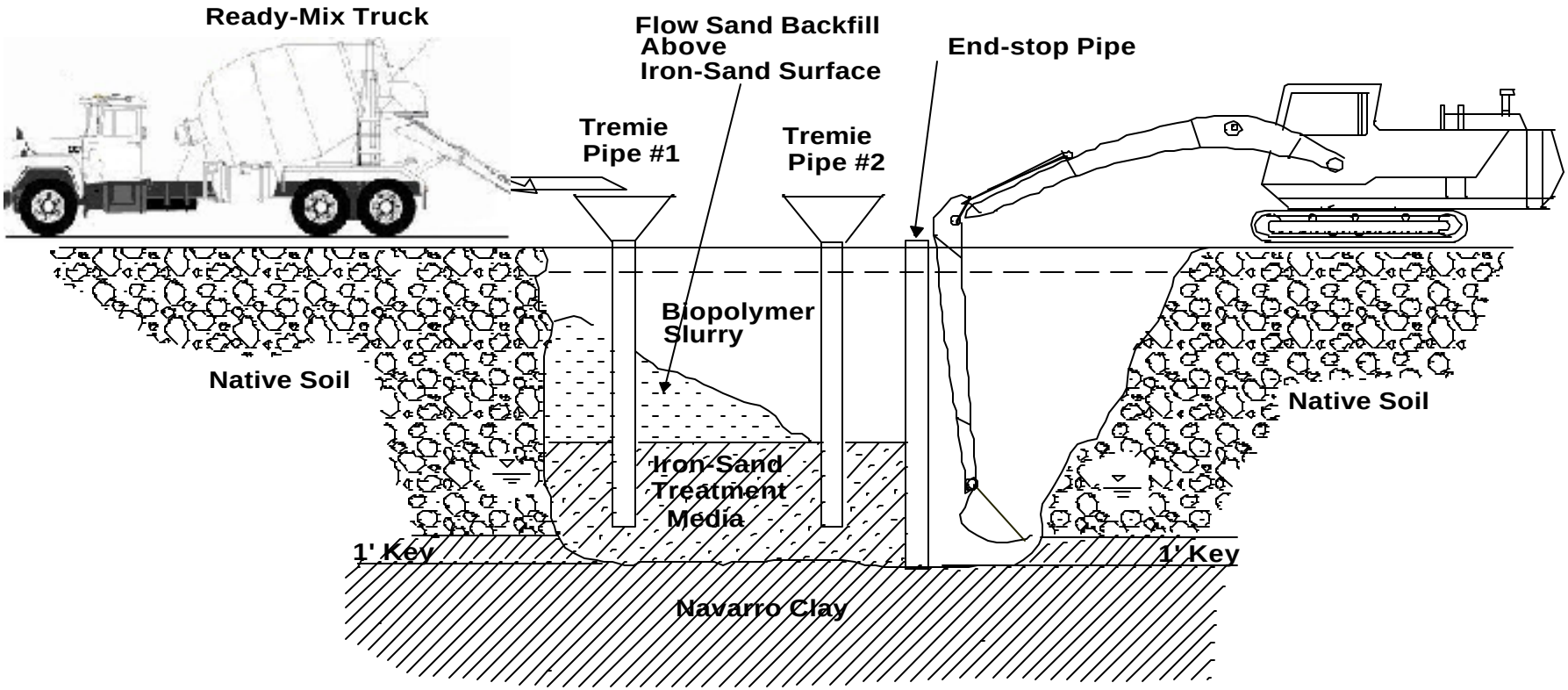


Figure 1

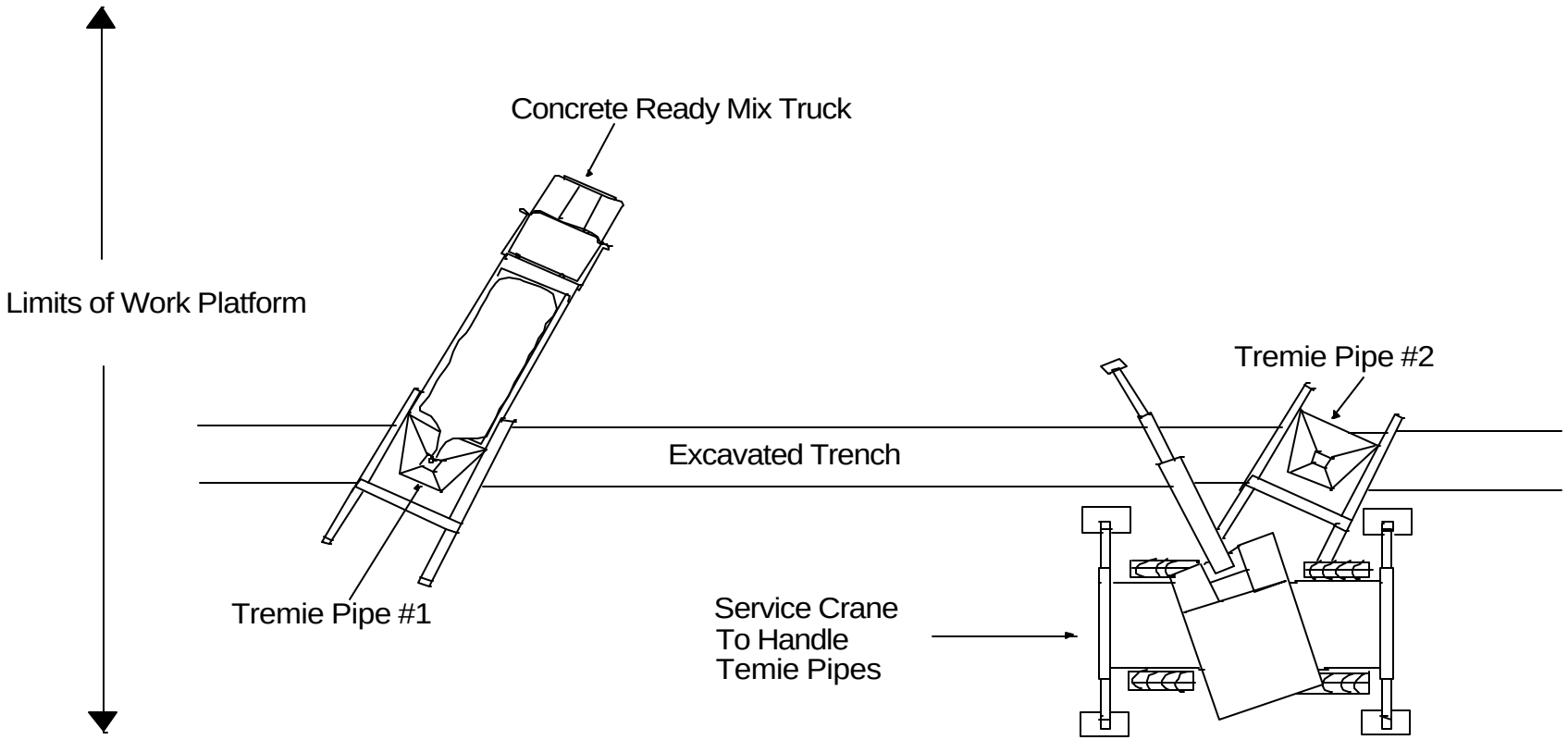
Typical Slurry Batch Plant Schematic
(NTS)

PRB Installation Sequence



Typical PRB Construction Schematic (NTS)

PRB Installation Sequence



Typical Schematic of Iron-Sand Tremie Operation (NTS)

Laboratory Slurry Compatibility

- Guar Gum is Tested for Compatibility with Site Mix Water, In-Situ Soil and Groundwater
- Slurry Mixtures are Monitored for:
  - Slurry Viscosity
  - Slurry pH
  - Slurry Unit Weight
- Slurry Mixtures Monitored for above Parameters for (7) Days Prior to Use
- This is Done to Insure Slurry Degradation Does Not Occur During Construction

Field Quality Control Testing

- **Biopolymer Slurry at Batch Plant**
  - **Slurry Viscosity**
  - **Slurry pH**
  - **Slurry Unit Weight**
- **Biopolymer Slurry in the Trench**
  - **Slurry Viscosity**
  - **Slurry pH**
  - **Slurry Unit Weight**
  - **Slurry Sand Content**

Field Quality Control Testing

- Reactive Media Prior to Placement in the Trench
  - Coarse Sand Gradation
  - Iron Filings Gradation (QA)
  - Magnetic Separation on Each Sand-Iron Batch
- Reactive Media After Placement in the Trench
  - Permeability of Sand-Iron Mixture
- Flowable Sand Prior to Placement in the Trench
  - Sand Gradation

Field Quality Control Testing

- During Slurry Trenching & Backfill Placement
  - Depth Sounding of each Excavated Segment
  - Depth Sounding of Trench Prior to Placement of Treatment Media
  - Depth Sounding and Slope Profile of Treatment Media After Placement
  - Depth Sounding and Slope Profile of Flowable Sand Above Treatment Media

Field Quality Control Testing

- Degraded Biopolymer Slurry
  - Degraded Slurry pH
  - Degraded Slurry Viscosity
  - Other Analytical Tests (Specific for Off-Site Disposal)
- Clay Cap Testing
  - Proctor Curve Development on Clay
  - Compaction Density Tests on Each Cap Lift

Benefits of Using Diverse Media

- **Very Cost Effective Since Iron Application is Tailored to each PRD Segment**
- **Effective Placement of Different Reactive Media Blends Can be Done Vertically and Horizontally**
- **Various Treatment Mixtures Can Blended to an Accuracy of (+) or (-) 2%**